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VAIDYANATHAN, Ranji [IN/US]; 2301 N. Sarnoff
Drive, Tuscon, AZ 85715 (US).

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(74) Agents: **SHADDOX, Robert, C.** et al.; Winstead Sechrest
& Minick P.C., 400 North Ervay Street, P.O. Box 50784,
Dallas, TX 75201 (US).

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(71) Applicant (*for all designated States except US*):
WILLIAM MARSH RICE UNIVERSITY [US/US];
6100 Main Street, Houston, TX 77843-1892 (US).

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(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **BARRERA, En-**
rique, V. [US/US]; 916 South Shepard, Houston, TX
77019 (US). **WILKINS, Richard** [US/US]; 2919 Adri-
enne Drive, College Station, TX 77845 (US). **SHOFNER,**
Meisha [US/US]; 1801 Wiswall Avenue, Watervliet,
NY 12189 (US). **PULIKKATHARA, Merlyn, X.**
[US/US]; 7827 Barberton, Houston, TX 77036 (US).

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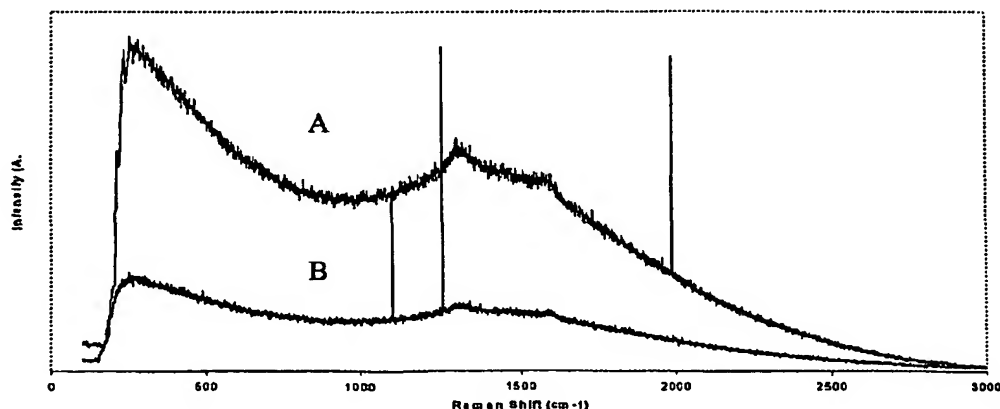
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[Continued on next page]

(54) Title: FUNCTIONALIZED CARBON NANOTUBE-POLYMER COMPOSITES AND INTERACTIONS WITH RADIATION



(57) Abstract: The present invention involves the interaction of radiation with functionalized carbon nanotubes that have been incorporated into various host materials, particularly polymeric ones. The present invention is directed to chemistries, methods, and apparatuses which exploit this type of radiation interaction, and to the materials which result from such interactions. The present invention is also directed toward the time dependent behavior of functionalized carbon nanotubes in such composite systems.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C08K C01B H01L D01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BOUL, P.J. ET AL.: "Reversible sidewall functionalization of buckytubes" CHEMICAL PHYSICS LETTERS, vol. 310, 3 September 1999 (1999-09-03), pages 367-372, XP002262089 cited in the application the whole document	1-10, 14, 15
X	BAHR, J.L. ET AL.: "Functionalization of Carbon Nanotubes by Electrochemical Reduction of Aryl Diazonium Salts: A Bucky Paper Electrode" JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, vol. 123, 14 June 2001 (2001-06-14), pages 6536-6542, XP002298712 cited in the application the whole document	1-35
Y	page 6541, second column, second paragraph ----- -/-	36-56

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+31-70) 340-3016

Authorized officer

Meiners, C

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International Application No

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MICKELSON, E.T. ET AL.: "Solvation of Fluorinated Single-Wall Carbon Nanotubes in Alcohol Solvents" JOURNAL OF PHYSICAL CHEMISTRY B, vol. 103, 7 May 1999 (1999-05-07), pages 4318-4322, XP002298713 cited in the application the whole document	1-4, 6-11, 13-16, 29-34
A	US 4 500 678 A (NAKANO HISAJI ET AL) 19 February 1985 (1985-02-19) abstract column 4, line 42 - line 65 column 6, line 7 - line 30 examples 1-3	1-56
A	DATABASE WPI Section Ch, Week 197635 Derwent Publications Ltd., London, GB; Class E19, AN 1976-65605X XP002298714 & JP 51 080219 A (CANON KK) 13 July 1976 (1976-07-13) abstract	1-56
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Y	claims 97-129	36-56
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A	WO 96/18059 A (HYPERION CATALYSIS INT) 13 June 1996 (1996-06-13) page 6, line 19 - page 12, line 7; claims 1,102-104; examples 5,7,12,17	1-28, 35-56
X	page 12, line 8 - line 27	29-34
A	WO 01/92381 A (BARRERA ENRIQUE V ; UNIV RICE WILLIAM M (US); LOZANO KAREN (US); CHIBA) 6 December 2001 (2001-12-06) page 35, line 12 - line 22	1-56

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INTERNATIONAL SEARCH REPORT

International Application No

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>KYMAKIS E ET AL: "Single-wall carbon nanotube/conjugated polymer photovoltaic devices"</p> <p>APPLIED PHYSICS LETTERS, AMERICAN INSTITUTE OF PHYSICS. NEW YORK, US, vol. 80, no. 1, 7 January 2002 (2002-01-07), pages 112-114, XP012030193</p> <p>ISSN: 0003-6951</p> <p>abstract</p>	36-56
X	<p>AGO H ET AL: "COMPOSITES OF CARBON NANOTUBES AND CONJUGATED POLYMERS FOR PHOTOVOLTAIC DEVICES"</p> <p>ADVANCED MATERIALS, VCH VERLAGSGESELLSCHAFT, WEINHEIM, DE, vol. 11, no. 15, 20 October 1999 (1999-10-20), pages 1281-1285, XP000869420</p> <p>ISSN: 0935-9648</p> <p>the whole document</p>	29-32, 34, 36-38, 42-48, 51,53-55
X	<p>DATABASE WPI</p> <p>Section Ch, Week 200280</p> <p>Derwent Publications Ltd., London, GB; Class A60, AN 2002-736938</p> <p>XP002313686</p> <p>-& JP 2002 273741 A (DOKURITSU GYOSEI HOJIN SANGYO GIJUTSU SO)</p> <p>25 September 2002 (2002-09-25)</p> <p>abstract</p> <p>paragraphs '0017!, '0049!; table 3</p>	29-32, 34, 36-40, 42-44, 54,55

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 03/38141

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this International application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
1-56
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-28

Invention I: a method comprising the steps of providing functionalized carbon nanotubes and effecting their defunctionalization, thus changing their properties, by exposure of the nanotubes to radiation. The carbon nanotubes are optionally dispersed in a host matrix, such as polymers or fluids.

2. claims: 29-56

Invention II: a) A device comprising a host material and functionalized and/or unfunctionalized carbon nanotubes dispersed in the host matrix. Emphasis is put on the modification of the electrical properties of the carbon nanotubes, which are defined by their level and type of functionalization. b) A sensor comprising a device capable of monitoring the radiation-sensitive electrical properties across a layer of functionalized carbon nanotubes-polymer composite material and a method of sensing. The layer forms also part of the sensor. c) A device comprising a polymer host matrix and functionalized carbon nanotubes, wherein the device uses time-dependent changes induced by exposure to radiation.

3. claim: 57

Invention III: a material designed for resisting effects of exposure to environmental conditions that becomes more resistant as a result of said exposure.

4. claims: 58,59

Invention IV: a process for rapid prototyping of carbon nanotube composites, wherein functionalized carbon nanotubes are used in place of nonfunctionalized carbon nanotubes to impart a viscosity that is more favorable to the process.

INTERNATIONAL SEARCH REPORT

Int'l Application No

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